V. zibetha examined by POCOCK (1939) was 53.5%, hardly different from that given for the *V. tainguensis*. The supposed difference becomes even less significant when one considers that the holotype of *V. tainguensis* is a subadult, that measurements of the adult paratype are not included in the description, and the only two specimens of *V. tainguensis* with accompanying morphometric data had tail to head-body length ratios of 53% and 56% (ROZHNOV and PHAM TRONG ANH 1999). Furthermore, neither publication dealing with *V. tainguensis* gave relative tail lengths for any *V. zibetha* specimens examined. Both merely quoted the figure from CORBET and HILL, (1992). Clearly, no convincing evidence has been presented to show that relative tail length can be used to distinguish *V. zibetha* from a second species to be known as *V. tainguensis*. (It should also be noted that SOKOLOV et al. (1997) stated that *V. megaspila* has a tail 45–55% of the length of its head-body. They appear to mean '*V. tangalunga*', which, according to CORBET and HILL (1992), does have a tail 45–55% of its head-body length, whereas in *V. megaspila* it is 30–50%.)

A fourth supposed distinguishing feature of *V. tainguensis* was stated to involve the pelage colour pattern. SOKOLOV et al. (1997) cited CORBET and HILL (1992) as stating that *V. tangalunga*, *V. zibetha*, and *V. megaspila* show little variation in their pelage pattern. Later, ROZHNOV and PHAM TRONG ANH (1999) cited the same source to support their contention that "Weak variation in external morphology is typical for all species of genus *Viverra*". These claims are incorrect. The first claim holds for *V. tangalunga*, but not for *V. megaspila* and it also involves a misinterpretation of a statement concerning *V. zibetha*. CORBET and HILL (1992) mentioned "little regional variation" in *V. zibetha*. This clearly refers to inter-regional, rather than intra-regional, variation. There is clearly a considerable degree of variation, both in pelage colouration and other characteristics in *V. zibetha*. The description of *V. z. surdaster* states "colour, as usual, variable, but with less tendency

to definite markings on the flanks and hips" (THOMAS 1927). OSGOOD (1932) stated that the species is "variable" and that "doubtless there are several recognizable races." POCOCK (1939), wrote "In *V. zibetha*... the coat, colour, and pattern vary considerably... The body-pattern is strongly pronounced in summer, indistinct or even obliterated in winter; and the ground-colour varies individually, even irrespective of season, from tawny to clear, almost silvery-grey... The differences ... in colour and pattern, now known to be individual and... seasonal, account for the number of names applied to most of the local races of this civet." Examination of existing specimens from south-east Asia clearly reveals the variability of the pelage pattern of *V. zibetha*. Specifically, SOKOLOV et al. (1997) considered there to be three distinctive pelage features of *V. tainguensis*: the "semi-lunar" spots, the colour pattern of the fore and hind legs, and the light brown stripe running parallel to the crest. All three of these features are present separately in *V. zibetha* specimens at the Muséum National d'Histoire Naturelle (MNHN). The "semi-lunar" spots can be observed in combination with both, one or none of the other pelage characteristics claimed for *V. tainguensis* in specimens from Vietnam, and is also a characteristic of a *V. zibetha* specimen from China (CG 1962-156 at the MNHN). Another specimen from China (CG 1902-688) displays the colour pattern on its legs but lacks the distinctive spots and lateral stripes, whilst a specimen from Vietnam (CG 1929–390, paratype of *V. z. surdaster*) has highly distinctive lateral stripes but lacks the colour pattern of the legs and any spots. Semi-lunar spots can also be observed on *V. zibetha* specimens of the BMNH from across the geographic range of the species. The pelage features stated to distinguish *V. tainguensis* will not separate this nominal form from all known individuals of *V. zibetha*.

In view of all of the above, insufficient evidence has been presented to suggest that *V. tainguensis* is in any way a distinct spe-

cies. However, a proposal to synonymise *V. tainguensis* with *V. zibetha* would be premature without an examination of the holotype. Thus, we propose that all records of *V. tainguensis*, except possibly that of the holotype, be withdrawn and that a re-examination of the holotype be undertaken.

References

Corbet, G. B.; Hill, J. E. (1992): The Mammals of the Indomalayan Region: a systematic review. London, Oxford: Natural History Museum Publ. and Oxford University Press.

Dang Huy Huynh; Dao van Tien; Cao van Sung; Pham Trong Anh; Hoang Minh Khien (1994): Checklist of Mammals in Vietnam. Hanoi: Vietnam National Centre for Natural Science and Technology.

Lekagul, B.; McNeely, J. A. (1977): Mammals of Thailand. Bangkok: Association for the Conservation of Wildlife (as updated 1988).

Osgood, W. H. (1932): Mammals of the Kelley-Roosevelts and Delacour Asiatic expeditions. Publ. Field Mus. Nat. Hist., Zool. Ser. **18**, 193–339.

Pocock, R. I. (1939): The Fauna of British India, Including Ceylon and Burma. Mammalia, 1. Primates and Carnivora (Felidae and Viverridae). London: Taylor and Francis, Ltd.

Rozhnov, V. V.; Pham Trong Anh (1999): A note on the Tainguen civet – a new species of viverrid from Vietnam (*Viverra tainguensis* Sokolov, Rozhnov and Pham Trong Anh, 1997). Small Carnivore Cons. **20**, 11–14.

Sokolov, V. E.; Rozhnov, V. V.; Pham Trong Anh (1997): New species of viverrids of the genus *Viverra* (Mammalia, Carnivora) from Vietnam. Zool. Zhurnal **76**, 585–589.

Sokolov, V. E.; Rozhnov, V. V.; Pham Trong Anh (1999): New data on *Viverra tainguensis* Sokolov, Rozhnov et Pham Trong Anh, 1997 (Mammalia, Carnivora) from Vietnam. Zool. Zhurnal **78**, 759–763.

Thomas, O. (1927): The Delacour exploration of French Indochina – Mammals. Proc. Zool Soc. London '**1927**', 41–58.

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Short communication

Response of *Apodemus flavicollis* to conditions at the altitude limit in the Western Tatra Mountains

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The occurrence of a species at the distribution border exhibits a dynamic pattern which sensitively reacts to the changing conditions of the environment as well as the state of the population of the species (Begon et al. 1997). The distribution border is set by at least one environmental factor close to its limiting value. Regardless of the patchiness of suitable habitat within the distribution range, the quality of habitat changes towards the distribution border from optimal through suboptimal to pessimal. Local populations adjacent to the distribution border react to the changes of local conditions and become extinct or are recolonized (Kozakiewicz 1993; Hanski et al. 1996) causing the distribution border to expand and contract (Angelstam et al. 1987).

The distribution border of *Apodemus flavicollis* (Melchior, 1834) includes a wide range of habitats and diverse climatic conditions due to its large distribution range (Niethammer 1978; Lura et al. 1995). The local occurrence and altitude tolerance of the species seems to be affected by the requirements of a continental climate (Lura et al. 1995) and food abundance (Angelstam et al. 1987). The seed abundance appears to be a critical factor affecting the distribution and population dynamics of

A. flavicollis. Populations are usually non-cyclic but density outbursts occur in years of high seed crop (Gurnell 1985; Angelstam et al. 1987; Pucek et al. 1993; Žiak and Kocian 1994). Considering habitat, *A. flavicollis* prefers mature deciduous forests with an open ground layer (Gurnell 1985). Therefore, the altitude range stretches from sea-level (Greece, Italy) to about 2 000 m (Alps) (Niethammer 1978; Yoccoz 1992).

The aim of this study is to investigate the population response and habitat selection of *A. flavicollis* to conditions at an altitude border in an upper subalpine zone.

The research was conducted in the Western Tatra Mts., Slovakia. The locality in the National Nature Reserve Roháče Lakes (elevation of the trapping grids: 1 570–1 600 m a. s. l.) represents a transition between a subalpine and an alpine zone due to climatic conditions caused by north-western orientation of the mountain range. The habitat is characterized by scattered patches of *Pinus mugo* cover, the occurrence of wet subalpine meadows, and a talus gradient of various rock sizes partially overgrown with vegetation dominated by *Juncus trifidus.*

Small mammal live-trapping was carried out in June, August, and October 1991–99

with the exception of 1992 and 1994 when trapping was carried out twice, in July and October. In the years 1991–95 two trapping grids were established, one 1 ha in size containing 10×10 live-traps, and the other 0.5 ha containing 6×8 live-traps, both with 10 m spacing. In 1996–99 another 1 ha trapping grid was added, and the trap layout was modified in the previous two grids giving in total two 1 ha grids with 7×7 live-traps at 15 m intervals, one 1.3 ha grid containing 10×13 live-traps at 10 m intervals. The traps were baited with rolled oats, operated for 3–5 consecutive nights, and were checked twice daily. Animals were marked by toe-clipping, data on species, body weight, sex, reproductive status (scrotal testes, open vagina, gravidity, lactation), and body length were recorded.

The habitat characterization was modified from DUESER and SHUGART (1978, 1979), and M'CLOSKEY and FIELDWICK (1975). The habitat at each trap point was characterized for the years 1996–98. The habitat variables were recorded in the summer series 1996–97 in a circle (diameter 10 m, or 15 m) centered on the trap. At each point, the proportion of the area covered by rocks, by rocks smaller and greater than 50 cm in diameter was registered. The vegetation structure was estimated by the proportion of the area covered by litter, herbs, shrubs and trees (including *Pinus mugo*), and specifically by dominant plant species: *Juncus trifidus, Vaccinium myrtillus, Pinus mugo*, and grasses other than *J. trifidus*. The total number of plant species present at the sample was recorded. The vegetation density below or above 50 cm was counted as the number of touches on a stick at 20 check-points forming a cross 10 + 10 centered on the trap and expressed as percent. The heights of herb, shrub and tree layers were measured at the same intersection depending on the availability of the given layer. Finally, the distance to the nearest patch of *Pinus mugo* larger than 30 m in diameter was recorded.

Discriminant function analysis was used to explore the microhabitat preferences of *A. flavicollis*. A qualitative model was chosen where trap points used by at least one resident individual, defined by the time span between first and last capture being at least two days, were referenced against trap points not used by resident individuals.

During the research time span (7 200 trap-nights) 12 species of small ground mammals were registered: *Sorex araneus, S. minutus, S. alpinus, Neomys* sp., *Apodemus flavicollis, Clethrionomys glareolus, Microtus nivalis, M. agrestis, M. tatricus, Muscardinus avellanarius, Mustela nivalis*, and *M. erminea* (ŽIAK and KOCIAN 1994; N. MARTÍNKOVÁ, D. ŽIAK, Ľ. KOCIAN unpubl.). *Apodemus flavicollis* has only been captured in the years 1993, 1996, and 1998 (Fig. 1). A total of 44 individuals was caught, 30 males and 14 females, a significant deviation from an expected sex ratio of 1 : 1 ($\chi^2 = 5.8$, p = 0.016). Except for two individuals, all animals were captured in one trapping series. The first exception was a sexually inactive female trapped in August and October 1993, and the second was a male trapped in August and October 1996, which was in breeding condition in August, but not so in October. No individuals were registered to stay the entire winter at the locality. Recaptures have also been rare with 60% of all individuals captured only one or two times, the average number of captures per individual being 2.3 and the maximum was eight (the sexually inactive female present in series VIII/93 and X/93). Individuals captured five or six times were all trapped in August 1996. No females were found demonstrating perforated vagina, or lactation, but one female may have been pregnant in August 1993. Among males, twenty-two possessed scrotal testes.

The discrimination of the preferred habitat of *A. flavicollis* was significant at p < 0.001. The discrimination model correctly classified 77% of unused trap points and 76% of used trap points (Tab. 1). Habitat variables that possess the highest absolute values of standardized coefficients influenced to a greater extent the position of samples on the discriminant function axes. This means that the variation of these variables best describes the differences between preferred and non-preferred habitat (LEGENDRE and LEGENDRE 1983). Variables associated with
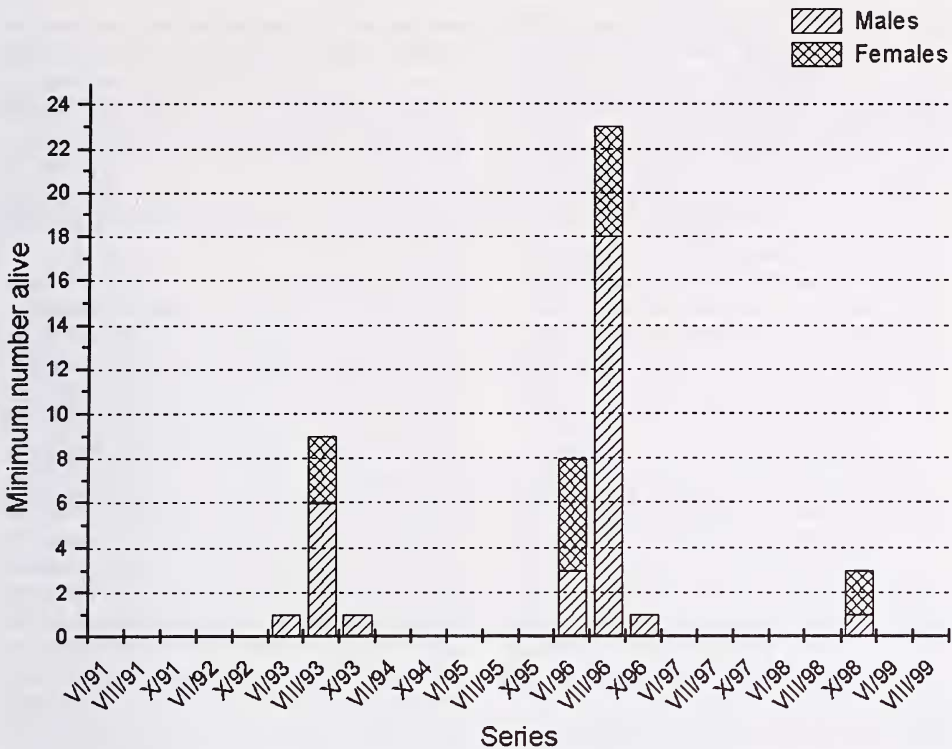
Fig. 1. Minimum number of *Apodemus flavicollis* known to be alive each season. Total number of yellow-necked mice being 44 individuals, where one individual was present in series VIII/93 and X/93, and another VIII/96 and X/96. Starting June 1996 methodology was changed so that 228 live-traps on three trapping grids were used instead of 148 on two grids.

Table 1. Discriminant function analysis coefficients characterizing habitat occupied by resident (time span between first and last capture being at least two days) individuals of *A. flavicollis* (p < 0.001). Habitat variables are ordered with regard to their importance in discriminating preferred and non-preferred habitat based on the absolute value of standardized coefficients.

Habitat variable	Standardized coef. of DFA	Average	Stand. Dev.
Vegetation density above 50 cm	−0,819	0,31	0,22
Distance from *Pinus mugo* patch	0,813	8,69	22,84
Pinus mugo cover	0,789	0,35	0,28
Area covered by rocks less than 100 cm in diameter	−0,417	0,06	0,14
Juncus trifidus cover	−0,399	0,07	0,17
Herb height	−0,393	35,05	15,28
Vaccinium myrtillus cover	−0,263	0,36	0,25
Grass cover	−0,246	0,43	0,31
Shrub height	−0,242	24,13	9,37
Vegetation density below 50 cm	−0,240	0,81	0,14
Area covered by rocks more than 100 cm in diameter	−0,180	0,06	0,11
Number of plant species	−0,125	8,06	2,98
Litter cover	0,071	0,09	0,16
Tree height	−0,060	148,40	61,55
Total area covered by rocks	0,031	0,12	0,22